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ABSTRACT

The purpose of this study was to investigate the teaching behavior and instructional methods of female elementary school teachers when engaged in mathematical instruction. This is a qualitative case study using the actual classroom setting as the source of data and the researcher as the instrument. Two female teachers were selected from each of the fourth- and sixth-grade levels of a New York State public school district. Each pair had matching amounts of teaching experience as well as comparable cohorts of mathematics students, yet the scores of each reflected opposite poles of mathematics attitudinal instruments. Data were collected through the use of tape recordings, an observational framework, field notes, unstructured and formal interviews, a student attitudinal questionnaire and artifacts during a two-month period. Findings on teacher dependence, learned helplessness, and independent learning behaviors with respect to teacher's attitude are discussed, as are implications for teacher education programs. (YP)

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ELEMENTARY SCHOOL TEACHERS' ATTITUDES TOWARD MATHEMATICS: IMPACT ON STUDENTS' AUTONOMOUS LEARNING SKILLS

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Mathematics knowledge and understanding are essential elements to successful functioning in our increasingly technological society. However, during the past several years comparative reports as well as internal studies have yielded alarming results which suggest that American students are ill prepared to reason logically and solve problems effectively when faced with mathematical tasks (Lee, Ichikawa, & Stevenson, 1986; Stevenson, Lee, & Stigler, 1986; Travers, 1987). Within the overall "underachieving" population of students, females in particular have been identified as having greater difficulty with higher level mathematical thinking, (Fennema & Peterson, 1985) exhibiting lower achievement (Mullis, 1975; Wise, Steel & McDonald, 1979), selecting fewer mathematics courses (Brush, 1979; Fox, 1981), and possessing more negative attitudes toward the subject (Fennema & Sherman, 1977). Surprisingly this is the same group that begins elementary school with measured superiority in mathematics (Walden & Walkerdine, 1981). Many researchers have tried to explain these changes through the investigation of both external and internal factors which may relate to female students' deteriorating performance and increasingly poor attitudes (Reyes, 1984).

Variables relating to schools have held particular promise since the subject of mathematics has been identified as an area in which school effects are especially influential (Coleman, 1975; Frank, 1988). School effects, moreover, can be changed more readily than more diffuse sociological factors. Most

previous investigative efforts have focused on the curricular content and students' learning without a careful consideration of teachers' instructional practices (Brophy, 1986). Therefore, this study examined teaching behaviors in mathematics as the events actually occurred and during the period of time (fourth to sixth grades) when females begin to lose ground in their mathematical performance (Brush, 1985; Maccoby and Jacklin, 1973).

PURPOSE

The purpose of the study was to document the teaching behavior and instructional methods of female elementary school teachers when engaged in mathematical instruction. This investigation examines the relationship of these behaviors to the teachers' attitudes toward mathematics. The specific research question guiding this investigation was: Do teachers with positive attitudes toward mathematics employ different methods in mathematics instruction than do those teachers with negative attitudes?

METHOD

The methodology selected for this investigation was the qualitative case study, using the actual classroom setting as the source of data and the researcher as the instrument. Since the behavior of the teacher was the focus of the study, it was essential to examine the decisions and actions made during the teaching process within the context in which it occurred.

The research site was a public school district in New York State where the student population had a varied socio-economic and racial background. All of the fourth and sixth grade teachers were given the Dutton Mathematics Attitude Scale (1976) and the Math Anxiety and Expectance Motivation subscales of the Fennema-Sherman Mathematics Attitude Scale (1976). The teachers' responses were scored and linked by an independent referee to the demographic information collected. The referee, without the researcher's input, then selected the sample of two female teachers from each of the grade levels under investigation. Each pair was matched so that they would have similar amounts of professional teaching experience and comparable cohorts of mathematics students (as the students were homogeneously grouped), yet their scores would reflect opposite poles of the attitudinal instruments. Since the researcher did not select the sample, she had no knowledge of which teacher held which attitudes; thus the researcher was not governed by these expectations in the examination of the teachers' behavior.

For two months the four teachers were observed during their scheduled math sessions. To determine those behaviors not exclusively practiced during mathematics teaching, the sample teachers were also observed in other subject areas during full day observations. Data were collected through the use of tape recordings, an observational framework, field notes, unstructured and formal interviews, a student attitudinal questionnaire and artifacts.

DISCUSSION OF FINDINGS

The daily experiences of students in mathematics classes of teachers with positive attitudes were found to be substantially different from those of students in classrooms of teachers with negative attitudes. The data suggest that these teachers with both similar professional backgrounds and students of comparable abilities engaged in dissimilar instructional activities. The identified differences have ramifications for the students, particularly for the female students.

Teacher Dependence

The instructional behaviors observed suggest that the teachers with negative attitudes frequently created teacher-dependent learning situations. Both the organization of lesson content and the materials chosen concentrated on the students' ability to produce the "one right answer." Consequently the teacher became the main source of the information required for the proper execution of procedures as well as the arbiter of the appropriate responses. In the area of instructional materials, the teachers with negative attitudes fostered dependence by using many more commercially prepared worksheets during their presentations and practice periods. Worksheets tended to stress algorithm practice rather than providing activities that seek affirmation of process comprehension. The nature of the material therefore encourages students to consult with the teacher for forgotten steps along the route in order to simply practice

mechanical procedures. Rather than being in any way self-instructive, the worksheets invite simple manipulations and narrow applications of computational skills, leaving independent thinking out of the classroom equation and reinforcing the perception of the teacher being in the critical role.

The pair of teachers with negative attitudes were observed providing instruction which was based on rules and memorization. They often relied on an algorithmic presentation which concentrated on correct answers and neglected the students' cognitive thought processes and mathematical reasoning. The students were encouraged to be passive learners, mechanically adhering to formulas developed through teacher regulated automaticity rather than on relevant practical usage. This type of teaching reinforces the belief that the teacher is the sole source of mathematical knowledge, which strengthens teacher-dependent behaviors by students. Holt (1964) describes the emphasis on student learning through the absorption of mathematical algorithms as an avenue to blind procedure compliance which both hinders critical thinking and restricts the development of problem solving skills. Fennema and Peterson (1985) have concluded that when mathematics is presented as rule-based and algorithm-centered, the skills necessary for higher level thinking are neglected. This finding is further complicated by the evidence that algorithm dependency has been identified as a critical factor in females' mathematics difficulties (Grieb & Easley, 1984).

Although the focus on memorized rules is in itself a problem for female students, the teacher-dominated and teacher-centered instructional situations described further confound the picture by the fact that females generally tend to be more dependent than males in academic situations (Bardwick, 1971; Garai & Scheinfeld, 1968; Kagan, 1964; Sherman, 1971). Dependency is "one of the two most extensively studied behaviors that are assumed to be sex-linked" (Maccoby and Jacklin, 1974, p. 191). This dependent behavior is evidenced through females' need for interaction, attention, reinforcement, and approval during the learning process. In particular it has been suggested that female elementary students are more dependent on their teachers as a result of identifying with them, precisely following their rules, and seeking frequent interaction (Lee & Gropper, 1974). Although these behavior patterns reap rewards in the early years of schooling, Lee & Gropper (1974) found they impede development by females of autonomous learning styles which are critical for acquiring abstract mathematical concepts and problem solving skills. Additionally female students have been found to be more dependent on feedback from external sources, such as teachers, to assess their performance (Dweck, Davidson, Nelson, & Enna, 1978). This dependence can lead to female students assessing their successes and failures according to subtle and overt messages from their mathematics teachers.

The dependence established between the mathematics teacher and both the female and male mathematics learner over many years

is a central concern. If in fact the students proceed under the reinforced and practiced assumption that the teacher is the only learning resource, then if they are unable to understand the instruction provided by the teacher or are incapable of generating a previously memorized procedure, they are at a total loss. They cannot transfer the necessary processes or apply higher level thinking to unusual or novel situations independent of the teacher.

Learned - Helplessness

The teacher-student dependency created through these behaviors is of particular concern for the female student population encouraging a learned helplessness among students. Learned helplessness is "the perception of independence between one's behavior and the presentation or withdrawal of an aversive event" (Dweck, 1975, p. 674). With reference to a classroom setting it can be further elaborated as a likely consequence when a student encounters failure and views his or her own effort as irrelevant in affecting future outcomes. Students who have developed a "Learned helpless syndrome" have been found to attribute their problems to factors which they see as either uncontrollable or unchangeable, such as ability, task difficulty, or attitudes of other people. Not only do females tend to exhibit this response-outcome independence and attribute failure to uncontrollable factors (Dweck & Reppucci, 1973; Nicholls, 1975) but they also tend to avoid situations in which they anticipate that failure is likely (Butterfield, 1965; Crandall &

Rabson, 1960). This is further complicated by the phenomenon that helplessness is more commonly limited to a specific area (e.g., mathematics), involvement in a particular activity (e.g., problem solving), or the presence of a particular person (e.g., the mathematics teacher) (Dweck & Reppucci, 1973).

The teachers with negative attitudes exhibited behaviors during their mathematics lessons that encouraged a learned helpless response. This respo9nse was engendered by limiting students' active involvement and opportunities to respond to questions, by answering their own questions, by writing equations and recording calculations for students, and by spending extended periods of time with individual students during periods of monitored practice. The teachers did not establish a model of student persistence, either by requesting student elaboration after a partially correct response or by giving a prompt at the point of an incorrect answer. Instead the teachers asked a question and often immediately responded with the answer. This behavior was not observed in isolated incidents but often occurred repeatedly for whole sections of recitations during which essentially no student input was invited. The students seem to be irrelevant as the teacher assumes both roles: asking questions and answering them. The lack of feedback in these cases discouraged student participation and active involvement while also possibly suggesting that the students were not expected to respond. Surely over a period of time the limited opportunities provided for the practice of persisting behaviors

could lead to the students developing a learned helpless response to interactions in mathematics instruction. The students may, in fact, believe that if they do not know the correct answer instantaneously, their efforts will nave no impact and persistence is useless. Research indicates that females need clarification on misunderstood concepts as well as additional opportunities to respond correctly to reduce the effect of failure feedback on performance (Dweck & Bush, 1976). The teachers' manner of providing answers to their own inquiries tends to encourage female students to attribute their inability to answer immediately to a lack of mathematical ability and to encourage passivity.

The teachers with negative attitudes were also observed doing things for some students while requiring other students to do the identical tasks themselves. This differential behavior was most apparent in the teachers' practice of writing equations or writing algorithmic procedures for the students. They were observed taking away the student's pencil or using their own to erase the student's work, rewrite the equation and carry out some of the mathematical processes. Again a similar message is suggested, namely that the students are not capable of accomplishing the task themselves and that the teacher is the mainstay for both verbal and written instruction. Such messages foster a learned helplessness response by encouraging the view that mathematics is a subject in which the teacher will take over a given task when the students make errors and thereby suggesting

that students need not exert themselves in the first place. These actions are even more interesting in that the teachers with negative attitudes toward mathematics only exhibited this behavior with female students. Clearly this behavior does not promote autonomous learning skills and may lead female students to internalize the belief that they cannot do mathematics tasks independently.

The seatwork portion of the lesson provided other observed differences in the behavior of the teachers with negative attitudes. These teachers spent more time with individual students at the students' desk or at the teacher's desk during monitored practice segments. Frequently they would spend two to three minutes at one location and at other times they devoted up to five uninterrupted minutes to a single student. Again it is interesting to note that all the extended contacts (two minutes or more) in the sixth grade class were with females and the large majority of the lengthy contacts in the fourth grade class were observed with female students as well. This practice of extended teacher assistance during the independent practice portion of the lesson, has been identified by several researchers (Good, Grouws, & Ebmeier, 1983) as comparable to unsupervised practice. Such protracted interaction was surprisingly found to result in more frequent errors for the students. It can be concluded therefore, that students who receive such prolonged periods of assistance from the teacher are deprived of the opportunity to practice the

behaviors necessary for independent work, again reinforcing a helplessness response.

Even in the absence of behaviors which encourage learned helplessness, research indicates that females are more prone to exhibit a learned helplessness response, particularly in mathematics (Dweck, Davidson, Nelson, & Enna, 1978; Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983). Additionally they more frequently demonstrate this behavior in situations in which they are evaluated by female adults (Dweck et al., 1978). Females consistently remain dependent on external evaluation to assess the quality of their academic performance while males are more autonomous in their learning (Dweck & Bush, 1976). Therefore, female students depend on their female teachers' feedback to assess their performance in a situation in which they are already unusually dependent. In this study students of the teachers with negative attitudes were observed receiving communications which prompted a learned helplessness response. Learned helplessness leads to an inability to persevere (Dweck & Bush, 1976) and therefore can be identified as a hindrance to autonomous learning behavior (Fennema & Peterson, 1985). Students learn what they practice. If they practice a learned helplessness response to mathematical endeavors they separate the effect of their efforts on outcomes. This results in a lack of practice in autonomous learning and independence is neither reinforced nor emphasized.

Independent Learning Behaviors

Most educators agree that independent learning is a major goal of education (Piaget, 1948). Schools can reinforce and encourage the already dependent or independent behaviors which students possess prior to coming to the school setting or, in the case of females, they can begin to establish new patterns of independence. Grieb and Easley (1984) found independence in learning to be critical for capturing the meaning of mathematics in both high level tasks and in applications to the real world. The teachers with negative attitudes did not encourage these autonomous learning behaviors but instead promoted heteronomy through reinforcing the passive assimilation of rules for solving problems without an understanding of the concepts involved. Undoubtedly there is little relationship between independent learning and memorization and rote computation.

One of the major problems in females' achievement in mathematics is the inability to perform tasks involving higher level thinking skills which are developed through the flexibility of independent learning behaviors. Female students, bounded by their rigid dependence on rules and authority, lack the skills needed to creatively address new mathematical situations or the irregularities of real world problems. In the present study, the teachers with negative attitudes toward mathematics provided students with algorithm-laden instruction that established teacher dependency. Because females frequently exhibit dependent behaviors, they are essentially a "high risk" group under these circumstances. In addition, the teachers' behaviors often

elicited a learned helpless response from the students, who found themselves unable to identify how their persistence and efforts were related to future outcomes. This helplessness was often reinforced when the teachers answered their own questions instead of providing the students with opportunities to think, reason, and discover responses logically. They also erased, wrote, and calculated for the students as well as spending extended periods of time with individual students during monitored practice. Again, these behaviors were more frequently evidenced with female students, and females are more inclined to exhibit the learned helplessness response. The combination of the dependency on the teacher and the helpless behaviors limit dramatically the possibilities for the development of independent learning and critical thinking. This may be a major factor contributing to gender differences in mathematics achievement.

In contrast, the teachers with positive attitudes toward mathematics used instructional methods that encouraged independence. They were more inclined to deal with skill development by delivering instruction which focused on why an algorithm works, demonstrating how certain mathematics skills are interrelated, discussing what properties are characteristic of a given skill, identifying the common problems encountered and providing appropriate means for proving correct answers. Besides resulting in less rule-based instruction the students explored and discovered mathematics meanings and interrelationships rather than passively receiving information. Students were frequently

not given algorithms but were instead provided with heuristics or ways of approaching problems without formulated computations. In this way the students were able to recreate their thinking and they were therefore better able to respond to novel situations and applications. It follows that student success in mathematical tasks is maintained for a longer period of time under these circumstances than for those students who rely on the memorization of the teachers' explanations.

The teachers with positive attitudes also incorporated instructional materials and representations that provided students with resources other than the teacher for self instruction. The teachers moved the students away from teacher dependence by suggesting that the students both mentally image the materials previously manipulated and model the teacher's behavior of pictorially representing problem situations. In this way the students were learning self reliance and practicing independent learning skills. In addition they are being trained to translate concepts to the visual area and use right-brain processing rather than the verbal and left brain action.

Another behavior that promoted independence was requesting that the students prove their answers; this process of self correction leads to the ability to cope with mathematical tasks independently because it gives students a better understanding of how to solve problems. In the process of verbally explaining their answers, the students were not only provided with an occasion to express their knowledge but to recognize mistakes and

develop self correcting behaviors. These episodes shifted the focus away from the teacher as the single source of information and encouraged students' persistence in examining their thinking and logic. The teachers themselves modeled persistence and self reliance by following up on the students' answers with opportunities for elaboration and through clue-giving in the case of incorrect answers or non-response situations. Rather than emphasizing teacher explanation and judgment of correctness, these teachers fostered self instruction, higher level thinking, and self correcting behaviors in their students.

Fennema and Peterson (1985) describe teacher actions such as encouraging independence and responsibility, building problem solving strategies or heuristics, building the students' self image, and acting as problem solving role models that lead to the development of autonomous learning behaviors. The teachers with positive attitudes were observed engaging in all of these activities. In summary, the teachers with positive attitudes nurtured independent learning skills through teaching heuristics and strategies, presenting active demonstrations, and by using representations and materials rather than a lockstep procedure presented as an abstract rule. They modeled persistent behaviors themselves and provided opportunities in which children could persist in their efforts until they met success or reached the goal of the lesson, thus giving the students proof that their efforts have a positive impact on learning outcomes. Students who are able to learn and think independently are better prepared

for the rigors of more abstract mathematical concepts and problem solving and do not develop a response of learned helplessness.

IMPLICATIONS

The findings of this study suggest the need for teacher training institutions and school district administrators to develop programs to help both pre-service teachers and teachers currently working in elementary schools to recognize and overcome the problem of negative attitudes toward mathematics and the instructional consequences of these attitudes. Such programs would ultimately help the teachers themselves and the students who they teach across many years. Mathematics anxiety, one component of attitudes towards mathematics, has been remediated quite successfully in programs for adult females (Tobias, 1987). This kind of program would be a helpful component of methods courses in universities and professional development activities in districts whose goal is to respond to the needs of these teachers. Another alternative would be the provision of in-service programs dealing with mathematics instruction. These programs would have flexible opportunities for individual contact with the instructor or consultant in addition to work in groups. In this way the teachers could receive personal attention addressing their specific problems within the context of their instructional circumstances. Without such intervention, teachers with negative attitudes will continue to present mathematics as a subject known only by an authority figure and comprised of information impossible to recreate without memorization and

assistance and impossible to transfer to new situations. These teachers may never fully develop professionally in this subject area and their own feelings of inadequacy may continue to be transmitted through their methods to classrooms of students for years to come.

References

Bardwick, J. (1971). Psychology of women: A study of bio-cultural conflicts. New York: Harper and Row.

Brophy, J. (1986). Teaching and learning mathematics: Where research should be going. Journal for Research in Mathematics Education, 17, 323-364.

Brush, L. (1979). Why women avoid the study of mathematics: A longitudinal study. ABT Associates, Inc., Cambridge, Mass. (ERIC Document Reproduction Service No. ED 188 887).

Brush, L. (1985). Cognitive and affective determinants of course preferences and plans. In S. Chipman, L. Brush, & D. Wilson (Eds.), Women and mathematics: Balancing the equation, Hilldale, NJ: Lawrence Erlbaum Associates.

Butterfield, E. (1965). The role of competence motivation in interrupted task recall and repetition choice. Journal of Experimental Child Psychology, 2, 354-370.

Coleman, J. A. (1975). Methods and results in the IEA studies of effects of school on learning. Review of Educational Research, 45 (3), 335-386.

Crandall, V. C., & Rabson, A. (1960). Children's repetition choices in an intellectual achievement situation following success and failure. Journal of Genetic Psychology, 97, 161-168.

Dutton, W. H. (1976). Dutton mathematics attitude scale. Form C, Scale 5.

Dweck, C. S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. Journal of Personality and Social Psychology, 31, 674-685.

Dweck, C., & Bush, E. (1976). Sex differences in learned helplessness: I. Differential debilitation with peer and adult evaluators. Developmental Psychology, 12, 147-156.

Dweck, C. S., Davidson, W., Nelson, S., & Enna, B. (1978). Sex differences in learned helplessness: II. The contingencies of evaluative feedback in the classroom, and III. An experimental analysis. Developmental Psychology, 14, 268-276.

Dweck, C. S., & Reppucci, N. D. (1973). Learned helplessness and reinforcement responsibility in children. Journal of Personality and Social Psychology, 25, 109-116.

Fennema, E. (1974). Sex differences in mathematics learning: Why??? The Elementary School Journal, 75, 183-190.

Fennema, E., & Peterson, P. (1985). Autonomous learning behavior: A possible explanation of gender-related differences in mathematics. In L. Wilkinson, & C. Marrett (Eds.), Gender influences in classroom interaction (pp. 17-35). New York: Academic Press.

Fennema, E., & Sherman, J. (1976). Instruments designed to measure attitudes toward the learning of mathematics by females and males. USAS Catalog of Selected Documents in Psychology, 6, 31.

Fennema, E. & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization and affective factors. American Educational Research Journal, 14, 51-71.

Fox, L. (1981). The problem of women and mathematics. New York: The Ford Foundation.

Frank, M. (1988). Problem solving and mathematical beliefs. Arithmetic Teacher, 35 (5), 32-34.

Garai, J., & Scheinfeld, A. (1968). A study of the interrelationship of factors affecting sixth grade students in respect to mathematics. School Science and Mathematics, 77, 489-494.

Good, T. L., Grouws, D. A., & Ebmeier, H. (1983). Active mathematics teaching. New York: Longman.

Grieb, H., & Easley, J. (1984). A primary school impediment to mathematical equity: Case studies in role-dependent socialization. In M. Steinkamp & M. Maehr (Eds.), Women in science. Greenwich, CT: JAI Press.

Kagan, J. (1964). Acquisition and significance of sex typing and sex role identity. In M. L. Hoffman and L. Hoffman (Eds.), Review of child development research. New York: Russell Sage Foundation.

Lee, P., & Gropper, N. (1974). Sex-role culture and educational practice. Harvard Educational Review, 44(3), 369-410.

Lee, S., Ichikawa, V., & Stevenson, H. W. (1986). Beliefs and achievement in mathematics and reading: A cross-national study of Chinese, Japanese, and American children and their mothers. Unpublished manuscript, Rackham School of Graduate Studies of the University of Michigan.

Leinhardt, G., & Greeno, J. (1986). The cognitive skill of teaching. Journal of Educational Psychology, 78, 75-95.

Maccoby, E. & Jacklin, C. (1973). Sex differences in intellectual functioning. In Assessment in a pluralistic society (anonymous). Proceedings of the 1972 Invitational Conference on Testing Problems. Princeton, NJ: Educational Testing Service.

Maccoby, E. E., & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

McCandless, B. (1961). Children and adolescents. New York: Appleton-Century-Crofts.

Mullis, I. (1975). Educational achievement and sex discrimination. Denver: National Assessment of Educational Progress. p.7.

Nicholls, J. (1975). Causal attributions and other achievement-related cognitions: Effects of task outcomes, attainment value, and sex. Journal of Personality and Social Psychology, 31, 379-389.

Piaget, J. (1948). To understand is to invent. NY: Grossman.

Reyes, L. (1984). Affective variables and mathematics education. The Elementary School Journal, 84, 558-581.

Sherman, J. (1971). On the psychology of women. Springfield, IL: Charles C. Thomas.

Stevenson, H. W. (1987). America's math problems. Educational Leadership, 45(2), 4-10.

Tobias, S. (1987). Mathematics anxiety: Causes and cures. Paper presented at the Long Island Mathematics Conference (LIMSCON), New York.

Travers, K. (1987). The underachieving curriculum: Assessing U. S. school mathematics from an international perspective. Champaign, IL: Stipes Publishing Company.

Walden, R. & Walkerdine, V. (1984). Girls and mathematics: The early years. London: Bedford Way Papers.

Wise, L., Steel, L., MacDonald, C. (1979). Origins and career consequences of sex differences in high school mathematics achievement (Report to the National Institute of Education, Grant No. NIE-G-78-001. Palo Alto, CA: American Institute for Research.

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